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1.ii) $I_C = I_S \exp(\alpha v_{BE}^2)$ $\alpha = \frac{1}{0.0179} V^{-2}$

$I_S = \left(5 + \frac{\Delta 1}{10}\right) \times 10^{-16} A$

$= 5.8 \times 10^{-13}$ mA

$\beta = 100 + \frac{\Delta 1}{10} = 100.8$

a) $\frac{\partial I_C}{\partial v_{BE}} = I_S \exp(\alpha v_{BE}^2) \times 2\alpha v_{BE}$

$g_m = I_C \times 2\alpha v_{BE}$

$I_C = 5.8 \times 10^{-13} \exp\left(\frac{0.7^2}{0.0179}\right) = 0.4486$ mA

$g_m = 2\alpha v_{BE} I_C$

$= \frac{2 \times 0.7}{0.0179} \times 0.4486$

$= 35.09 \ (k\Omega)^{-1}$

b) $v_{R_C} = \frac{v_{dd}}{2} = 2.9V$

$I_C = 0.4486$ mA

$R_C = 6.464 \ k\Omega$

c) The voltage drop across R_E should be around $v_{RE} = 0.5V$ for stable bias

bias current should be small to ensure less power loss through biasing.

d) $v_X = (10 I_B) R_2$ to ensure less current $I_B = \frac{I_C}{\beta} = 4.153 \times 10^{-3}$ mA

or $1.2 = 41.53 \times 10^{-3} R_2$ $v_X = v_{RE} + v_{BE}$

or $R_2 = 28.89 \ k\Omega$ (Ans)

$\frac{v_{dd} R_2}{R_1 + R_2} = 1.2$ $R_1 = 110.768 \ k\Omega$ (Ans)

or $R_1 + R_2 = 139.65 \ k\Omega$

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e) $A_V = -g_m R_C$
$= -35.09 \times 6.464$
$= -226.82$

f) 3 poles are expected for 3 capacitors, associating one pole with each node.

g) $|\omega_{p1}| = \dfrac{1}{C_{C1}(R_1 \| R_2 \| r_\pi)} = 78.41 \text{ rads}^{-1}$

$|\omega_{p2}| = \dfrac{1}{C_E\left(R_E \| \frac{1}{g_m}\right)} = 7656.95 \text{ rads}^{-1}$

$|\omega_{p3}| = \dfrac{1}{C_{C2} R_C} = 32.91 \text{ rads}^{-1}$

$R_E = \dfrac{0.5}{0.4486} = 1.114 \text{ k}\Omega$

$\dfrac{1}{g_m} = 0.028 \text{ k}\Omega$

$R_1 = 110.768 \text{ k}\Omega$
$R_2 = 28.89 \text{ k}\Omega$
$r_\pi = \dfrac{\beta}{g_m} = 3.077 \text{ k}\Omega$

$R_1 \| R_2 \| r_\pi = 2.713 \text{ k}\Omega$